CLAIMS

What is claimed is:

1. 1. A method of seismic data processing to correct for variable water velocities, the
2. method comprising:
3. (a) determining an observed velocity;
4. (b) determining a vertical time correction using said observed velocity; and
5. (c) applying said vertical time correction to seismic data before normal
6. moveout.

1. 2. The method of claim 1 wherein determining an observed velocity further
2. comprises determining V_{obs} from $V_{obs} = V_w \left(\Delta t / T_{obs} + 1 \right)$

1. 3. The method of claim 1 wherein determining an observed velocity further
2. comprises determining V_{obs} from velocity analysis of a seismic gather.

1. 4. The method of claim 1 wherein determining said vertical time correction further
2. comprises determining a time-dependent and offset-dependent correction for at
3. least one sample of the seismic data.

1. 5. The method of claim 1 wherein said vertical time correction is of the form
2. $\Delta t(\theta) = T_{obs} \left(V_{obs} / V_w - 1 \right) / \left\{ 1 - \left[H V_{obs} / \left(T_{refl} (H) V_{rms}^2 \right) \right]^2 \right\}^{1/2}$ where V_w is a selected
3. ideal velocity.

1   6.   A method for determining a water velocity correction for seismic data, the method

2   comprising:

3   (a)   determining a zero-offset static correction, Δt, for the seismic data that is

4   the difference between an observed time to a water bottom and an ideal

5   time to a water bottom determined using a selected ideal velocity;

6   (b)   selecting an ideal water velocity, V_w, for the seismic data;

7   (c)   determining a zero-offset water bottom time for the seismic data;

8   (d)   determining an observed velocity, V_{obs}, for the seismic data; and

9   (e)   determining a water velocity dynamic correction.

1   7.   The method of claim 6 wherein determining said water velocity time correction

2   further comprises determining a time-dependent and offset-dependent correction

3   for at least one sample of the seismic data.

1   8.   The method of claim 6 wherein said water velocity dynamic correction is of the

2   form $\Delta t(\theta) = T_{obs}\left(V_{obs}/V_w - 1\right)/\left\{1 - \left[HV_{obs}/\left(T_{refl}\left(HV_{rms}^2\right)\right)\right]^2\right\}^{1/2}$.

1   9.   The method of claim 6 wherein said water velocity dynamic correction is

2   determined for at least one source-receiver offset.

1   10.   The method of claim 6 wherein deriving said water velocity dynamic correction

2   further comprises determining at least one angle of seismic data raypaths for at

3   least one source-receiver offset.

1   11.   The method of claim 6 wherein determining an angle of seismic raypaths through

2   the water uses velocities from at least one of the list consisting of: i) normal

3   moveout velocities V_{rms}, ii) observed velocities V_{obs}, and iii) ideal velocities V_w.

1   12.   The method of claim 6 wherein determining said water velocity dynamic

2   correction further comprises determining at least one seismic raypath through the

3   water using velocities from at least one of the list consisting of: i) normal

4   moveout velocities V_{rms}, ii) observed velocities V_{obs}, and iii) ideal velocities V_w.

1   13.   The method of claim 12 wherein deriving said seismic raypaths further comprises

2   determining raypaths between a water surface and a water bottom, said water

3   bottom defined by using at least one of the group consisting of i) T_w, ii) T_{obs} and

4   iii) an arbitrary water bottom model.

1   14.   The method of claim 6 wherein deriving said water velocity dynamic correction

2   further comprises determining V_{obs} from $V_{obs} = V_w\left(\Delta t/T_{obs} + 1\right)$

1   15.   The method of claim 6 wherein deriving said water velocity dynamic correction

2   further comprises determining V_{obs} from velocity analysis of a seismic gather.

1   16.   A method of seismic data processing, the method comprising:

2   (a)   determining a zero-offset static correction, Δt, for the seismic data that is

3   the difference between an observed time to a water bottom and an ideal

4   time to a water bottom determined using a selected ideal velocity;

5   (b)   selecting an ideal water velocity, V_w, for the seismic data;

6   (c)   determining a zero-offset water bottom time for the seismic data;

7   (d)   determining an observed velocity, V_{obs}, for the seismic data;

8   (e)   determining a water velocity dynamic correction; and

9   (f)   applying said water velocity dynamic correction to seismic data.

1   17.   The method of claim 16 wherein said water velocity dynamic correction is

2   substantially of the form $\Delta t(\theta) = T_{obs} \left(V_{obs}/V_w - 1\right) / \left\{ 1 - \left[H V_{obs} / \left(T_{refl}(H) V_{rms}^2\right) \right]^2 \right\}^{1/2}$.

1   18.   The method of claim 16 wherein determining an observed velocity, V_{obs}, is of the

2   form $V_{obs} = V_w \left(\Delta t / T_{obs} + 1\right)$

1   19.   The method of claim 16 wherein said water velocity dynamic correction is

2   determined for at least one source-receiver offset.

1   20.   The method of claim 16 wherein determining said water velocity dynamic

2   correction further comprises determining at least one seismic raypath through the

3   water using velocities from at least one of the list consisting of: i) normal

4   moveout velocities V_{rms}, ii) observed velocities V_{obs}, and iii) ideal velocities V_w.

1   21.   The method of claim 20 wherein deriving said seismic raypaths further comprises

2   determining raypaths between seismic receivers and a water bottom defined by at

3   least one of the group consisting of i) T_w, ii) T_{obs} and iii) an arbitrary water

4   bottom model.

1   22.   The method of claim 16 wherein deriving said water velocity dynamic correction

2   further comprises determining V_{obs} from $V_{obs} = V_w \left(\Delta t / T_{obs} + 1\right)$

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1   23.   The method of claim 16 wherein deriving said water velocity dynamic correction

2   further comprises determining V_{obs} from velocity analysis of a seismic gather.

1   24.   A method of seismic data processing to correct for variable water velocities, the

2   method comprising:

3   (a)   determining an observed velocity;

4   (b)   determining an angle dependent time correction using said observed

5   velocity; and

6   (c)   applying said angle dependent time correction to seismic data before

7   normal moveout.

1   25.   The method of claim 24 wherein determining said observed velocity further

2   comprises determining V_{obs} from $V_{obs} = V_w \left(\Delta t / T_{obs} + 1 \right)$

1   26.   The method of claim 24 wherein determining said observed velocity further

2   comprises determining V_{obs} from velocity analysis of a seismic gather.

1   27.   The method of claim 24 wherein determining said angle dependent time

2   correction further comprises determining a time-dependent and offset-dependent

3   correction for at least one sample of the seismic data.

1   28.   The method of claim 24 wherein said vertical time correction Δt, is of the form

2            $\Delta t(\theta) = T_{obs} \left(V_{obs} / V_w - 1 \right) / \left\{ 1 - \left[H V_{obs} / \left(T_{refl} (H) V_{rms}^2 \right) \right]^2 \right\}^{1/2}$ where V_w is a selected

3   ideal velocity.